„*Agriculture and Food – current and future challenges* - **AGRIFA**” 8 October 2021, Cluj-Napoca

A PERSPECTIVE OF THE GEOCHEMICAL CHARACTERIZATION OF GROUNDWATER SOURCES IN THE CENTRAL PART OF ROMANIA

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INTRODUCTION

One of the most important water supply sources is represented by an essential natural source - the groundwater. Groundwater sources have the potential of being potable water supplies and are considered to be safer than surface waters. However, anthropogenic activities and the interactions with the environment and the geological materials affect and alter their quality. Assessing the quality, chemical and geochemical properties represents an important step in protecting and conserving the quality in a sustainable way.

Objectives

- Assessment of the hydrochemical properties of groundwaters;
- Determination of the groundwater typology;
- Identification of the geochemical processes.

MATERIAL AND METHOD

A number of 15 water samples (1-15) were collected from an urban area situated in the central part of Romania (Sibiu County). The sample campaign was organized randomly, in the warm season, from private water wells. Eight physico-chemical parameters were determined (pH, total dissolved solids, HCO_3, Cl, SO_4, Ca, Mg, Na and K) by using an ion chromatograph (IC 761 Compact, Methrom Switzerland), an inductively coupled plasma optical emission spectrometer (Optima 5300 DV, Perkin Elmer, Canada), a multi pH meter (Multi 350i, WTW, Germany); volumetric and gravimetric methods were performed for the TDS and HCO_3 content. Based on the chemical composition, different diagrams were obtained, such as the Piper, Durov, Ternary, Stiff and Schoeller.

RESULTS AND DISCUSSIONS

Based on the Schoeller diagram, the trend of the studied chemical parameters was determined as being normal, dominated by the HCO_3+CO_3 content, followed by Ca, SO_4, Na+K, Cl and Mg (Figure 1).

Generally, according to the Piper diagram-diamond-shaped field, the studied groundwater samples were classified into two water typologies: 1. $CaHCO_3$ type (87 %) and mixed $CaNaHCO_3$ (13 %), as indicated in Figure 1. The principal cation is represented by Ca and the main cation is represented by HCO_3.

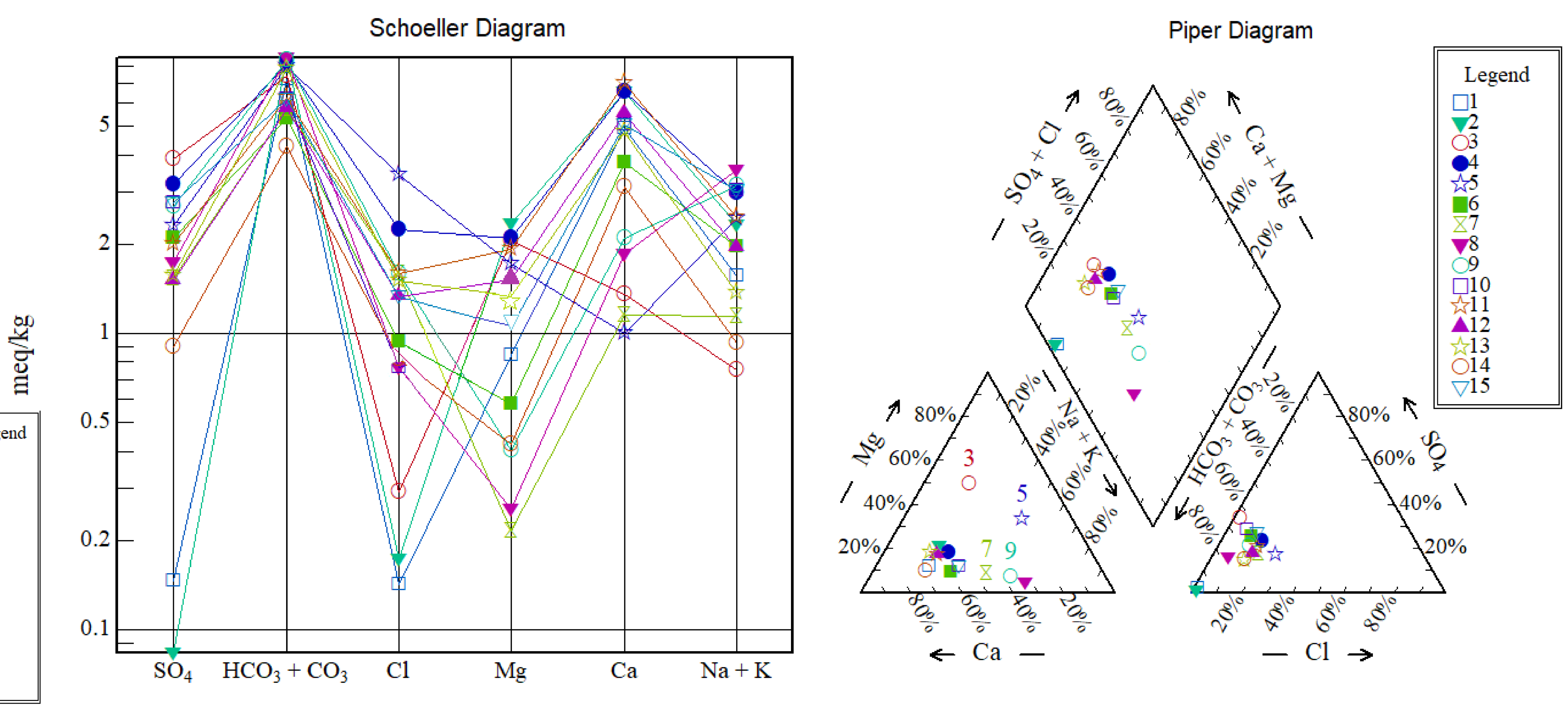
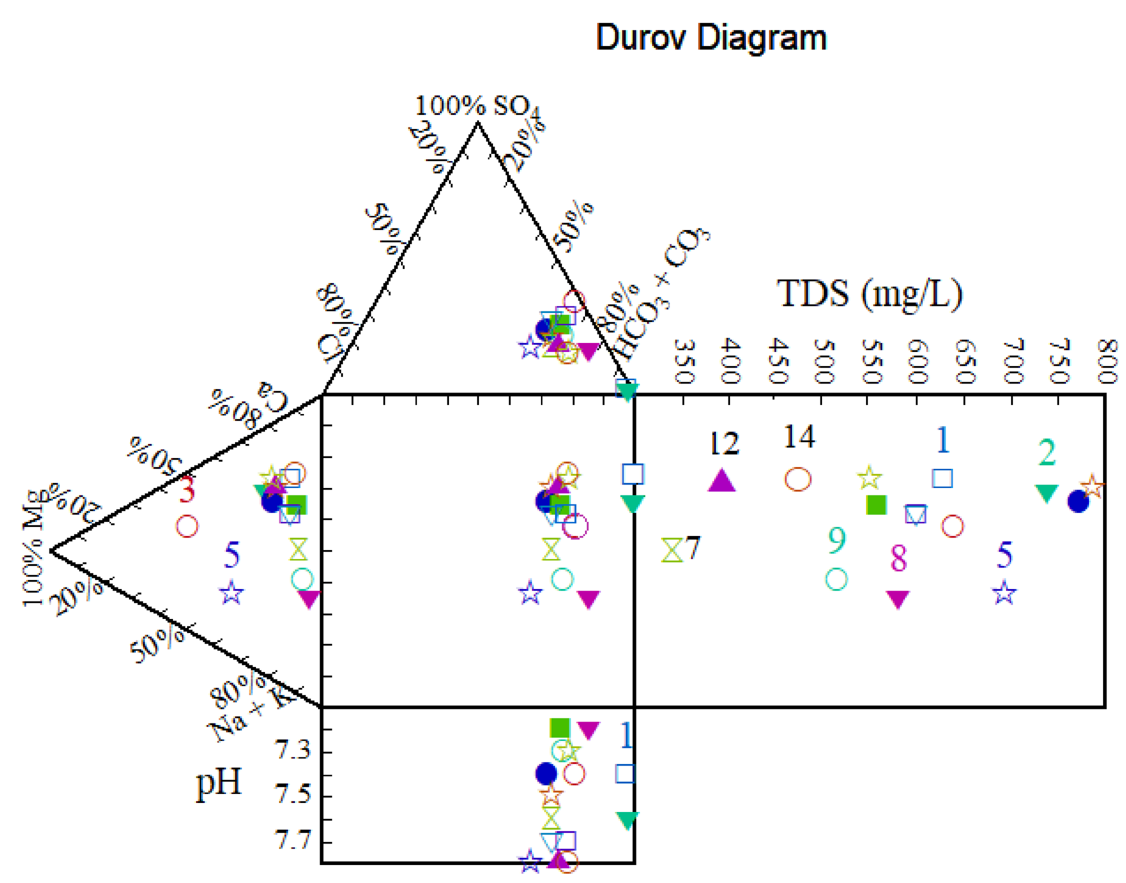


Figure 1. *Schoeler and Piper plots applied for the studied water samples*



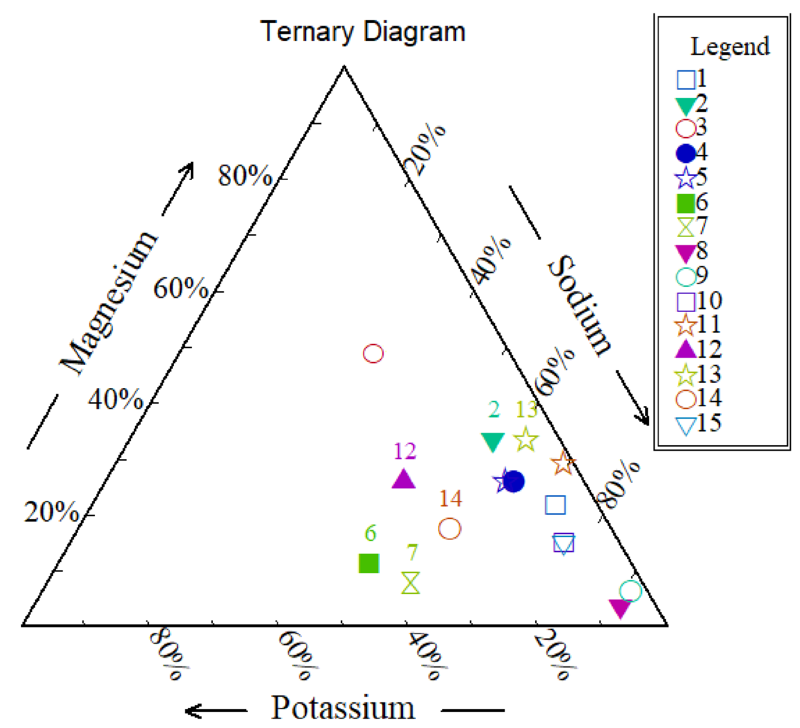
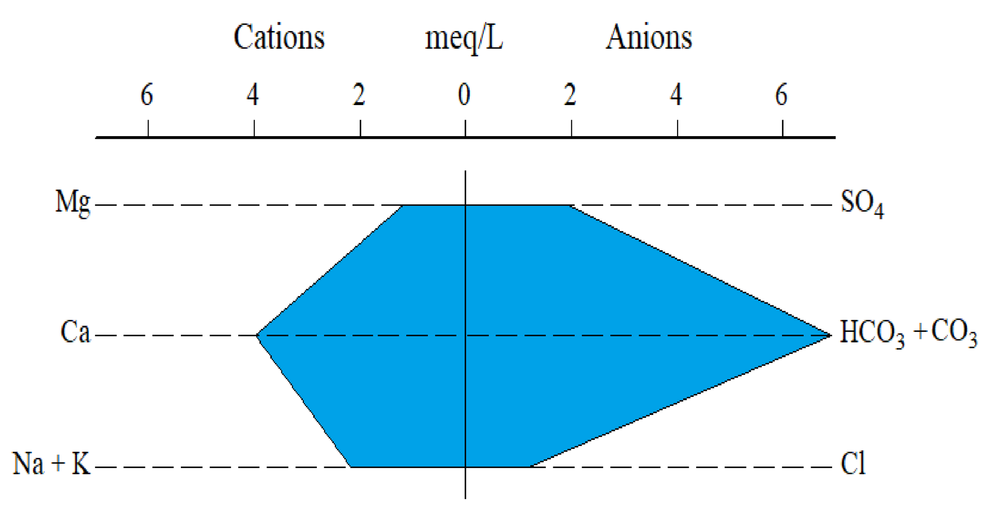


Figure 2. *Durov, Ternary and Stiff (for average concentrations) plots applied for the studied water samples*



The Durov diagram is generally used for identifying the geochemical processes which affect the chemistry of groundwater sources (Chegbeleh et al., 2020). The possible hydrogeochemical processes influencing the studied groundwater samples, based on the Durov plot (Figure 2), were the infiltration of water and cation exchange. The considerable amount of HCO_3 was attributed to the dissolution of carbonate minerals and silicate.

The Stiff diagram is a pattern diagram used for the representation of hydrochemical data (processes and facies), according to Chegbeleh et al. (2020). It was observed that Ca-HCO_3+CO_3 dominated, while Mg-SO_4 and Na+K-Cl were nearly equal in proportion.

The Ternary plot was used to show the correlation between the major cations, indicating the dominance of Na being inversely proportional to K. Positive correlations were determined between EC (electrical conductivity) - TDS (total dissolved solids), EC-Mg, TDS-Mg and Ca-Mg, as indicated in Table 1.

Table 1. *Pearson correlation matrix applied for the groundwater samples*

Var	Var1	pH	EC	TDS	HCO_3	Cl	SO_4	Ca	Mg	Na	K
Var1	**1**	0.310	-0.387	-0.387	-0.482	0.091	0.098	0.114	-0.311	0.106	-0.093
pH	0.310	**1**	-0.140	-0.140	-0.557	0.305	-0.134	0.087	0.196	-0.157	0.121
EC	-0.387	-0.140	**1**	**1.00**	0.446	0.164	0.156	0.459	**0.698**	0.403	-0.335
TDS	-0.387	-0.140	**1.00**	**1**	0.446	0.165	0.156	0.460	**0.698**	0.403	-0.335
HCO_3	-0.482	-0.557	0.446	0.446	1	0.031	0.111	-0.071	0.271	0.494	-0.424
Cl	0.091	0.305	0.164	0.165	0.031	1	0.406	-0.226	0.066	0.325	0.045
SO_4	0.098	-0.134	0.156	0.156	0.111	0.406	1	-0.239	0.170	0.219	0.029
Ca	0.114	0.087	0.459	0.460	-0.071	-0.226	-0.239	1	**0.501**	0.221	-0.029
Mg	-0.311	0.196	**0.698**	**0.698**	0.271	0.066	0.170	**0.501**	1	-0.012	-0.044
Na	0.106	-0.157	0.403	0.403	0.494	0.325	0.219	0.221	-0.012	1	-0.334
K	-0.093	0.121	-0.335	-0.335	-0.424	0.045	0.029	-0.029	-0.044	-0.334	1

CONCLUSIONS

The pressure on groundwater sources during the last decades has been continuously increasing due to the water demands and to the increase of the population. In the present study, the quality of 15 groundwater sources was assessed. The chemical analysis results revealed that the geochemistry displays Ca>Na>K>Mg and HNO_3>SO_4>Cl trends. The studied water samples were classified into mixed water typologies $CaNaHCO_3$ and $CaHCO_3$, according to the Piper diagram. The geochemical processes affecting the quality of groundwaters were the cation exchange and the infiltration of water. Significant correlations were noticed between EC-TDS-Mg-Ca, confirming the action of the two geochemical processes.

ACKNOWLEDGMENTS

This work was supported by the Ministry of Research and Innovation through Program 1 - Development of the National Research and Development System, Subprogram 1.2 - Institutional Performance - Projects for Financing Excellence in RDI, Contract No. 19PFE/2018 and by the Competitiveness Operational Programme of the Ministry of European Funds through the Contract No. 7/01.09.2016, MY SMIS 10565.

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